



A modified totally stapled KONO-S anastomosis for ileal and ileo-colic Crohn's disease: technical aspects and case series

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Abstract

Crohn's disease (CD) is a chronic immune-mediated disorder affecting the gastrointestinal tract. While medical therapies have advanced, approximately 80% of CD patients will require surgery due to disease recurrence. A significant debate exists regarding the primary site of post-operative recurrence. This discrepancy in recurrence patterns underscores the complexity of CD management and the ongoing need for tailored surgical approaches. It has been recently demonstrated that the Kono-S anastomosis is safe and efficient in reducing endoscopic and surgical recurrence. Newer versions of the Kono-S anastomosis using staplers have been reported to further simplify the procedure and decrease operative time. The aim of this paper was to describe a distinct version of a totally stapled Kono-S anastomosis and provide preliminary results from our center. The technical procedure of a totally stapled Kono-S anastomosis is illustrated. A consecutive series of patients undergoing ileal or ileo-colic resection followed by totally stapled Kono-S anastomosis was identified from a prospectively collated database. Data included patient demographics and baseline characteristics, intraoperative details, short- and long-term post-operative outcomes. Between January and November 2023, 41 patients (mean age 36.4 years, 61% males) underwent ileal or ileo-colic resection followed by totally stapled Kono-S anastomosis for Crohn's disease. Mean operative time was 150.76 ± 43.22 min, and mean time of anastomotic construction was 19.71 ± 4.24 . Time to flatus and stool were 2.73 ± 0.70 and 3.51 ± 1.16 days, respectively, and the length of post-operative stay was 6.80 ± 2.13 days. Only two patients (4.8%) presented complications following surgery, namely anastomotic bleeding. At a mean follow-up of 17.0 ± 2.1 months, no patient needed re-do surgery for disease recurrence at anastomotic site. The endoscopic recurrence rate was 14.4% (4/28). Our fully stapled version of the Kono-S anastomosis is safe and feasible, and short construction time and low technical complexity may help its diffusion among colorectal surgeons. Long-term outcomes on disease recurrence are still to be defined.

Keywords Crohn's disease · Kono-S anastomosis · Surgical techniques

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Introduction

Crohn's disease (CD) is a well-recognized immune-related disorder that involves pathological changes in the gastrointestinal tract. While the management of CD requires strict monitoring of bowel-related symptoms, serum inflammation markers as well as routine endoscopy checkups for exploring luminal disease activity, 80% of CD patients still require surgery during their lifetime [1, 2]. Moreover, even though a myriad of biological molecules has been developed and succeeded in controlling CD-related symptoms, disease recurrence, mainly at anastomotic site, remains a major issue, and the reoperation rate of CD patients is still high, reaching 35% of total surgery cases [3]. A significant debate exists regarding the primary site of post-operative recurrence. Other researches, including those by Rutgeerts et al., suggest that recurrence predominantly occurs in the neo-terminal ileum rather than at the anastomotic site [4]. This discrepancy in recurrence patterns underscores the complexity of CD management and the ongoing need for tailored surgical approaches. While medical therapies can control symptoms, disease recurrence, particularly in the neo-terminal ileum, remains a critical challenge.

This prompted the exploration of novel surgical techniques to reduce recurrences after CD surgery. The Modified Rutgeerts' score is used to assess recurrence, with i2a representing anastomotic recurrence and i2b indicating recurrence in the neo-terminal ileum [5].

Stapled side-to-side anastomosis is currently the technique of choice for bowel reconstruction after intestinal resection in CD [6]; nevertheless, this type of anastomosis has been associated with high recurrence rate along the surgical staple line [7].

Recently, a new hand-sewn anti-mesenteric functional end-to-end anastomosis, called Kono-S anastomosis, has emerged as an alternative strategy, featuring a wide lumen and an anti-mesenteric configuration which may prevent disease relapse from the mesenteric side [8]. Various studies including a large randomized controlled trial have confirmed the safety and efficiency of this novel technique in reducing the incidence of endoscopic and surgical recurrence [9, 10].

Given the technical complexity of the hand-sewn method, stapled versions of the Kono-S anastomosis have been developed, preserving the essential principles of mesenteric exclusion and wide-lumen anastomosis while simplifying the procedure [11–13]. Adhering to the basic principles of the original anastomosis, the stapled versions may be more time-saving and easier to perform and standardize.

Herein, we aimed to describe our version of a totally stapled Kono-S anastomosis after ileal or ileo-colic

resection for CD, with highlights on the critical technical steps. Secondary aim was to provide preliminary surgical results from our center.

Methods

Study setting and population

All patients undergoing ileal or ileo-colic resection followed by stapled Kono-S anastomosis for Crohn's disease at the Department of Colorectal surgery and Oncology of the Second Affiliated Hospital Zhejiang University School of Medicine, Hangzhou, Zhejiang (China) between January and November 2023 were identified from a prospectively collected database and considered in the study.

The diagnosis of Crohn disease was established by clinical symptoms, endoscopic findings, and pathologic data, according to the European Crohn's and Colitis Organization (ECCO) criteria [14].

Exclusion criteria included patients with comorbid conditions that contraindicated surgery or those on long-term immunosuppressive therapy.

Prior to surgery, each case was discussed at a weekly multidisciplinary meeting of the IBD unit, composed of gastroenterologists, surgeons, radiologists, and pathologists. After the referral for surgery, each patient received a detailed explanation of the procedure by the medical staff and had to sign a personalized informed consent form. All the operations were performed by the same experienced surgeon (XL).

This study is reported according to the STROBE statement for cohort studies and was conducted according to the ethical principles stated in the Declaration of Helsinki [15].

Data collection and study outcomes

Data collected included patient demographics and baseline characteristics [age, sex, smoking status, American Society of Anesthesiologists (ASA) grade, BMI, disease duration prior to surgery, disease behavior and location according to Montreal classification, pre-operative medical therapy, previous CD surgery], intraoperative data [type of surgical intervention, operative time, anastomosis time (defined as time from transection of bowel segments to last reinforcement suture), stoma rate, presence of intraoperative complications], and short- (time to flatus and stool, length of hospital stay, presence of complications like anastomotic leak or bleeding, bowel obstruction, surgical site infection, according to Clavien–Dindo classification) and long-term (surgical recurrence, defined as reoperation with resection for recurrent disease at the Kono-S anastomotic site; endoscopic recurrence was defined as Rutgeerts' score of $\geq$ i2b

from post-operative endoscopy within 6 to 12 months) post-operative outcomes. The primary endpoint of this study was the evaluation of feasibility, the safety, and the short-term post-operative outcomes and complications after totally stapled Kono-S anastomosis. The secondary endpoint was the assessment of long-term surgical recurrence.

Surgical technique

After laparoscopic exploration and, in case of ileocolonic disease, mobilization of right colon and terminal ileum, the

diseased bowel is exteriorized through a 5 cm midline incision in order to perform the extra-corporeal anastomosis.

In general, 5 cm margins from the affected bowel are prepared.

The steps of the anastomosis creation are as follows (Fig. 1a–j):

- After tailoring the mesentery, the proximal and distal bowel segments are placed in a parallel position and the pathological bowel loop is resected using a linear stapler perpendicular to the mesentery, taking care that

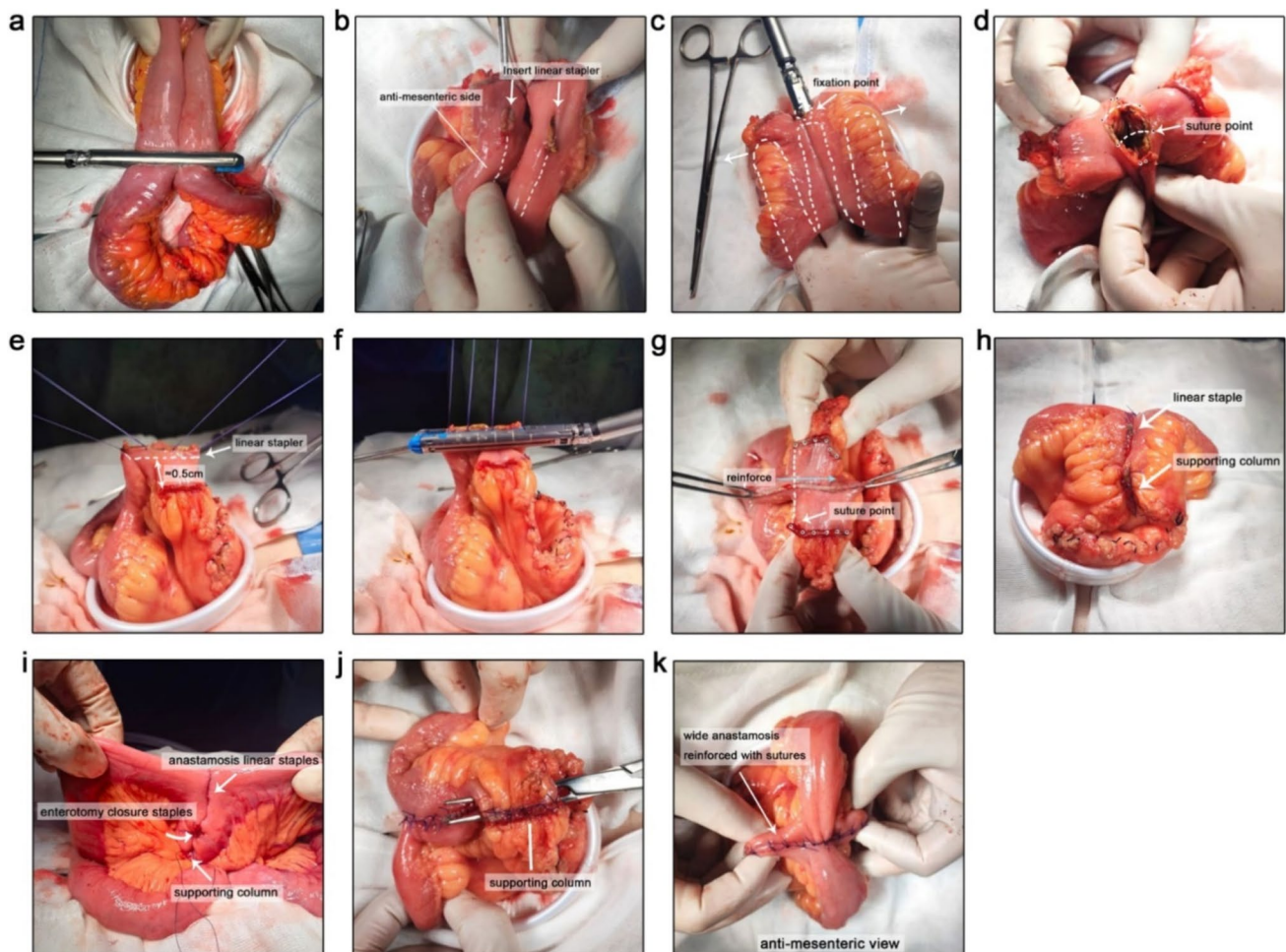


Fig. 1 Surgical Technique. **a** The diseased bowel is divided using a linear stapler perpendicular to the axis of the mesentery, with the mesenteric side located in the middle of the staple line. **b** Two 1 cm longitudinal enterotomies are created 1 cm from the staple line on the anti-mesenteric side of each bowel segment. **c** A 60 mm linear stapler is applied to make an anti-mesenteric side-to-side anastomosis. The index finger and the fourth finger spread toward opposite directions while the middle finger and the thumb hold the bowel (at the fixing point) at the apex of the stapler, ensuring sufficient anti-mesenteric cutting. **d, e** The enterotomy is lifted by suspension sutures which bring together the lateral sides. **f** After accommodation to the jaws

of a 60 mm linear stapler using the suspension sutures, the enterotomies are sealed off by the stapler. **g, h** The anastomosis is reinforced with interrupted sutures around the anastomosis line and continuous sutures for the residual (enterotomy) staple lines. The staple line of the proximal and distal bowel is sutured together to create the supporting column. **i** Side view of the anastomosis showing the linear (side to side) staples, the residual (enterotomy) staples and the supporting column with no connection between the anastomosis and the mesentery. **j** Superior view showing the supporting column. **k** Anti-mesenteric view showing a wide anastomosis identical to the canonical hand-sewn KONO-S anastomosis

the mesenteric side of both bowel segments is located at the center of the stump.

- b. Two 1 cm longitudinal enterotomies are created 1 cm from each staple line on the anti-mesenteric side of each bowel segment.
- c. After disinfection of the bowel lumen, a 60 mm linear stapler is applied to make an anti-mesenteric side-to-side anastomosis which also merges the two enterotomies.
- d. After probing the anastomotic lumen with a cotton stick to check for anastomotic bleeding and adequate luminal width, the enterotomy is lifted by one suspension suture on each end and 2–3 more suspension sutures to bring together the lateral sides.
- e. After accommodation to the jaws of a 60 mm linear stapler using the suspension sutures, the enterotomies are sealed off by the stapler.
- f. Interrupted sutures around the anastomosis line and continuous sutures for the residual staple lines are used to reinforce the anastomosis and prevent intraluminal bleeding.
- g. After the construction and reinforcement of the actual anastomosis, the staple line of the proximal and the distal bowel are sutured together by 4 or 5 stitches to create the supporting column, which seals the space between the anastomotic lumen and the mesentery.

Statistical analysis

Statistical analysis was performed using the Statistical Package for Social Sciences (SPSS software v.15.0, Chicago, IL) for Windows. Categorical data are presented as frequencies and associated percentages. Continuous data are presented as mean and standard deviation or median and IQR according to data distribution.

Results

A total of 44 totally stapled Kono-S anastomosis procedures have been performed in 41 patients (mean age 36.4 years, 61% males) during the study period.

Mean disease duration before surgery was 5.6 ± 4.2 years. Ileum (L1) was the most common disease location (75.6%) and stenosing disease (B2) was the most common disease behavior (83.0%). All patients except one had a primary CD, with no history of previous IBD surgery. The majority of patients (43.9%) were under treatment with biologic drugs at time of surgical intervention. Demographic and baseline characteristics of the patients are reported in Table 1.

In total, 34 ileo-ileal and 10 ileo-colic fully stapled Kono-S anastomoses were performed. Mean operative time was 150.76 ± 43.22 min, with a mean anastomosis time of

Table 1 Patients' characteristics

Age, years	36.4 ± 13.1
Males: Females	25:16
Active smokers, <i>n</i> (%)	3 (7.3%)
BMI, kg/m ²	19.55 ± 2.90
ASA class	
II	37 (90.2%)
III	3 (7.3%)
IV	1 (2.4%)
Disease duration, years	5.6 ± 4.2
Disease pattern	
B2 (stenosing)	34 (83.0%)
B3 (penetrating)	7 (17.0%)
Disease location	
L1 (ileal)	31 (75.6%)
L3 (ileocecal)	7 (17.0%)
L1 + L3 (ileal + ileocecal)	3 (7.3%)
Recurrent disease, <i>n</i> (%)	1 (2.4%)
Preoperative therapy	
No therapy	16 (39.0%)
ASA, <i>n</i> (%)	5 (12.2%)
Immunomodulators, <i>n</i> (%)	2 (4.8%)
Biologics, <i>n</i> (%)	18 (43.9%)

19.71 ± 4.24 min. No patients required a stoma creation. No intraoperative complication was reported.

Mean time to first flatus and stool were 2.73 ± 0.70 and 3.51 ± 1.16 days, respectively. Mean post-operative hospital stay was 6.80 ± 2.13 days.

Two patients (4.8%) presented rectal bleeding during their hospital stay: one was successfully treated conservatively with a watchful-wait approach (Clavien–Dindo I), while the other underwent a colonoscopy which eventually found blood clots and no active bleeding at the anastomotic site (Clavien–Dindo III).

At a mean follow-up of 17.0 ± 2.1 months, no patients presented surgical recurrence. Twenty-eight patients received endoscopy checkup between 6 and 12 months after surgery, with a mean Rutgeers' score of 0.93. Among them, 3 patients had a score of i2b and 1 patient had a score of i3, adding up to 4 cases of endoscopic recurrence.

Intra- and post-operative outcomes are reported in Table 2.

Discussion

CD is a chronic inflammatory bowel disease which often requires surgery for the treatment of complications like strictures and fistulas of the affected intestinal segments. Nevertheless, even after the surgical resection of the diseased

Table 2 Intra- and post-operative outcomes

Operative time, min	150.76 ± 43.22
Anastomosis time, min	19.71 ± 4.24
Time to flatus, days	2.73 ± 0.70
Time to stool, days	3.51 ± 1.16
Length of post-operative stay, days	6.80 ± 2.13
Major complications	
Rectal bleeding, <i>n</i> (%)	2 (4.8%)
Anastomotic leak, <i>n</i> (%)	–
Bowel obstruction, <i>n</i> (%)	–
Surgical recurrence	0 (0%)
Mean Rutgeerts score	0.93
Endoscopic recurrence	4/28 (14.4%)

bowel, the rate of post-operative recurrence (POR) is dramatically high, with most CD patients presenting relapse of luminal disease activity (endoscopic recurrence) and/or intestinal symptoms (clinical recurrence) that may even require further surgical interventions (surgical recurrence) [16].

The high recurrence rate of the conventional side-to-side anastomosis and the evidence of disease relapse occurring at the mesenteric side of the bowel led to the development of new mesentery-excluding surgical strategies aimed to reduce POR [17]. Trying to pursue this same objective, Coffey and colleagues focused on extended mesentery excision, while Kono and colleagues developed a new anti-mesenteric anastomotic configuration [18]. The new Kono-S anastomosis, fashioned as a hand-sewn anti-mesenteric functional end-to-end anastomosis, demonstrated improved endoscopic and surgical recurrence rates in a first cohort study and a multicentric series [8, 19]. These results were further confirmed by a randomized controlled trial by Luglio et al. comparing the Kono-S with the conventional side-to-side anastomosis, which showed a reduction in endoscopic and clinical recurrence rates in patients receiving the new anastomosis [10].

Despite the promising outcomes, the technical complexity and the longer construction time associated with the hand-sewn technique may limit its spread and even make its standardization difficult. In our fully stapled version of the Kono-S anastomosis, all principles of the original configuration have been preserved: the mesentery is divided close to the bowel wall in order to provide adequate innervation and vascularization, and a large lumen anti-mesenteric anastomosis is fashioned before the two stumps are sutured together to create the “supporting column”, which gives stability to the anastomosis and excludes it from the mesenteric side. The choice of constructing the anastomosis before the supporting column came after preliminary attempts with the opposite, more conventional, procedure, in which the exposure and the closure of the enterotomies and the reinforcement of the

anastomotic line were made more challenging by the presence of the “rigid” supporting column posteriorly.

Previous studies on hand-sewn Kono-S anastomosis did not report the time for anastomosis construction as a study outcome. Nevertheless, we suggest that our fully stapled version could consist of a faster but also easier procedure since its technical steps do not differ much from those of the conventional side-to-side anastomosis, described by Ravitch and Steichen in 1972 and performed by most colorectal surgeons for many types of surgical interventions [20]. Apart from the feasibility, we also showed that our technique can be safe because it was associated with average recovery time and a low complication rate, with only one patient requiring an endoscopic procedure for suspected anastomotic bleeding. Finally, even though the study period was too short, preliminary results at a mean follow-up of 6 months showed no surgical recurrence at anastomotic site.

This study demonstrates that the fully stapled version of the Kono-S anastomosis is technically feasible and safe, with promising short-term outcomes. While the original hand-sewn Kono-S technique was designed for ileo-colic anastomosis, we successfully adapted this procedure for both ileo-colic and ileal resections, which accounted for the majority of cases in our series.

However, the absence of B1 (luminal disease) patients highlights a limitation as early surgical intervention in luminal CD is becoming increasingly common. Future studies should include a broader patient spectrum to better assess the technique's applicability.

The mean hospital stay of 6.80 days, though longer than expected, may reflect institutional practices and patient complexity. Further research should investigate ways to streamline post-operative recovery in these patients.

Finally, while short-term results were encouraging, the study's brief follow-up period prevents us from drawing definitive conclusions about the long-term efficacy of the fully stapled Kono-S anastomosis in preventing recurrence.

Recent findings, particularly from the KoCoRICCO study by Alibert et al., challenge the assumption that Kono-S anastomosis significantly reduces recurrence compared to conventional ileocolonic anastomosis [21]. Their nationwide propensity score-matched study, found no significant difference in recurrence rates between the two techniques. This contrasts with earlier studies suggesting a recurrence-reducing benefit of Kono-S due to its anti-mesenteric configuration [21]. While our study demonstrates the technical feasibility and the short-term safety of the fully stapled Kono-S anastomosis, the findings of the KoCoRICCO study highlight the need for longer follow-up and further research to assess its true long-term efficacy.

To our knowledge, this is the first study describing a new but coherent fully stapled version of the Kono-S anastomosis and providing preliminary post-operative results on a

medium-sized series of patients. Our fully stapled Kono-S anastomosis showed to be feasible and safe, with potential benefits in terms of constructing time and technical simplicity which may improve the diffusion of this new promising surgical procedure among colorectal surgeons. The advantages in terms of long-term POR are still to be defined, as for the hand-sewn Kono-S anastomosis, with a longer follow-up and a larger patient population.

Although the lack of a randomized comparison with the classical hand-sewn KONO-S technique may limit the generalizability and broader scientific impact of our findings, this study lays the groundwork for further research. There is a clear need for future randomized trials to directly compare the outcomes of the hand-sewn and stapled KONO-S techniques. Such studies will be essential to definitively evaluate the potential advantages offered by this technical modification.

Author contributions All authors contributed significantly to the present research and reviewed the entire manuscript. X.L., M.C., T.Y., P.S., M.M., L.D., S.T. and F.M.M.: Participated substantially in the conception, design, and execution of the study and in the analysis and interpretation of the data and also participated substantially in the drafting and editing of the manuscript. All authors have read and agreed to the published version of the manuscript.

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Data availability The data that support the findings of this study are available from the corresponding author upon request.

Declarations

Conflict of interest The authors have no conflict of interest to declare.

Informed consent All involved persons gave their informed consent prior to study inclusion.

Ethical approval Ethical approval from the local hospital board was obtained before study initiation.

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